Michigan Department of Transportation
5100B (07/07)

# CHECKLIST TO DESIGNATE AREAS OF EVALUATION FOR REQUESTS FOR PROPOSAL (RFP)

Exhibit B

| MDOT PROJECT MANAGER | JOB NUMBER (JN) | CONTROL SECTION (CS) |
|---|---|---|
| Greg Krueger | | |

DESCRIPTION IF NO JN/CS
Mackinac Bridge Message Signs

**MDOT PROJECT MANAGER:** Check all items to be included in RFP.

WHITE = REQUIRED
GRAY SHADING = OPTIONAL

Check the appropriate Tier in the box below

| ☐ **TIER I ($25,000-$99,999)** | ☒ **TIER II ($100,000-$250,000)** | ☐ **TIER III (>$250,000)** | **CONSULTANT:** Provide only checked items below in proposal. |
|---|---|---|---|
| ☐ | ☒ | ☐ | Understanding of Service |
| ☐ | ☒ | ☐ | *Innovations* |
| ☐ | ☒ | ☐ | *Safety Program* |
| N/A | ☒ | ☐ | Organization Chart |
| ☐ | ☒ | ☐ | Qualifications of Team |
| ☐ | ☒ | ☐ | Past Performance |
| Not required as part of official RFP | Not required as part of official RFP | ☐ | Quality Assurance/Quality Control |
| ☐ | ☒ | ☐ | **Location:** The percentage of work performed in Michigan will be used for all selections unless the project is for on-site inspection or survey activities, then location should be scored using the distance from the consultant office to the on-site inspection or survey activity. |
| N/A | N/A | ☐ | Presentation |
| N/A | N/A | ☐ | Technical Proposal (if Presentation is required) |
| 3 pages (MDOT forms not counted) **(No Resumes)** | 7 pages (MDOT forms not counted) | 19 pages (MDOT forms not counted) | Total maximum pages for RFP **not including key personnel resumes** |

# REQUEST FOR PROPOSAL



The Michigan Department of Transportation (MDOT) is seeking professional services for the project contained in the attached scope of services.

If your firm is interested in providing services, please indicate your interest by submitting a Proposal, Proposal/Bid Sheet or Bid Sheet as indicated below. The documents must be submitted in accordance with the latest "Consultant/Vendor Selection Guidelines for Service Contracts" and "Guideline for Completing a Low Bid Sheet(s)", if a low bid is involved as part of the selection process. **Referenced Guidelines are available on MDOT's website under Doing Business > Vendor/Consultant Services >Vendor/Consultant Selections.**

## RFP SPECIFIC INFORMATION

☑ BUREAU OF HIGHWAYS ☐ BUREAU OF TRANSPORTATION PLANNING ** ☐ OTHER

THE SERVICE WAS POSTED ON THE ANTICIPATED QUARTERLY REQUESTS FOR PROPOSALS

☑ NO ☐ YES DATED _____ THROUGH _____

☑ **Prequalified Services** – See page 1 of the attached Scope of Services for required Prequalification Classifications.

☐ **Non-Prequalified Services** - If selected, the vendor must make sure that current financial information, including labor rates, overhead computations, and financial statements, if overhead is not audited, is on file with MDOT's Office of Commission Audits. This information must be on file for the prime vendor and all sub vendors so that the contract will not be delayed.

☑ **Qualifications Based Selection** – Use Consultant/Vendor Selection Guidelines

**For all Qualifications Based Selections,** the section team will review the information submitted and will select the firm considered most qualified to perform the services based on the proposals. The selected vendor will be contacted to confirm capacity. Upon confirmation, that firm will be asked to prepare a priced proposal. Negotiations will be conducted with the firm selected.

****For RFP's that originate in Bureau of Transportation Planning only**, a priced proposal must be submitted at the same time as, but separate from, the proposal. Submit directly to the Contract Administrator/Selection Specialist, Bureau of Transportation Planning **(see address list, page 2)**. The priced proposal must be submitted in a sealed envelope, clearly marked **"PRICE PROPOSAL."** The vendor's name and return address MUST be on the front of the envelope. The priced proposal will only be opened for the highest scoring proposal. Unopened priced proposals will be returned to the unselected vendor(s). Failure to comply with this procedure may result in your priced proposal being opened erroneously by the mail room.

**For a cost plus fixed fee contract**, the selected vendor must have a cost accounting system to support a cost plus fixed fee contract. This type of system has a job-order cost accounting system for the recording and accumulation of costs incurred under its contracts. Each project is assigned a job number so that costs may be segregated and accumulated in the vendor's job-order accounting system.

☐ **Qualifications Review / Low Bid** - Use Consultant/Vendor Selection Guidelines. See Bid Sheet Instructions for additional information.

For Qualification Review/Low Bid selections, the selection team will review the proposals submitted and post the date of the bid opening on the MDOT website. The notification will be posted at least two business days prior to the bid opening. Only bids from vendors that meet proposal requirements will be opened. The vendor with the lowest bid will be selected. The selected vendor may be contacted to confirm capacity.

☐ **Best Value** - Use Consultant/Vendor Selection Guidelines. See Bid Sheet Instructions below for additional information. The bid amount is a component of the total proposal score, not the determining factor of the selection.

☐ **Low Bid** (no qualifications review required - no proposal required.) See Bid Sheet Instructions below for additional instructions.

## BID SHEET INSTRUCTIONS

A bid sheet(s) must be submitted in accordance with the "Guideline for Completing a Low Bid Sheet(s)" (available on MDOT's website). The Bid Sheet(s) is located at the end of the Scope of Services. Submit bid sheet(s) separate from the proposal, to the address indicated below. The bid sheet(s) must be submitted in a sealed manila envelope, clearly marked **"SEALED BID."** The vendor's name and return address MUST be on the front of the envelope. Failure to comply with this procedure may result in your bid being opened erroneously by the mail room and the bid being rejected from consideration.

## PROPOSAL SUBMITTAL INFORMATION

| REQUIRED NUMBER OF COPIES FOR PROJECT MANAGER | PROPOSAL/BID DUE DATE | TIME DUE |
|---|---|---|
| 5 | 1/7/09 | 12:00PM |

## PROPOSAL AND BID SHEET MAILING ADDRESSES

Mail the multiple proposal bundle to the MDOT Project Manager or Other indicated below.

☐ MDOT Project Manager

☑ MDOT Other

Michele Mueller
18101 W Nine Mile Road
Southfield, MI 48075

Mail one additional stapled copy of the proposal to the Lansing Office indicated below.

| | Lansing Regular Mail | OR | Lansing Overnight Mail |
|---|---|---|---|
| ☑ | Secretary, Contract Services Div - B470<br>Michigan Department of Transportation<br>PO Box 30050<br>Lansing, MI 48909 | | Secretary, Contract Services Div - B470<br>Michigan Department of Transportation<br>425 W. Ottawa<br>Lansing, MI 48933 |
| ☐ | Contract Administrator/Selection Specialist<br>Bureau of Transportation Planning B470<br>Michigan Department of Transportation<br>PO Box 30050<br>Lansing, MI 48909 | | Contract Administrator/Selection Specialist<br>Bureau of Transportation Planning B470<br>Michigan Department of Transportation<br>425 W. Ottawa<br>Lansing, MI 48933 |

## GENERAL INFORMATION

Any questions relative to the scope of services must be submitted by e-mail to the MDOT Project Manager. Questions must be received by the Project Manager at least four (4) working days prior to the due date and time specified above. All questions and answers will be placed on the MDOT website as soon as possible after receipt of the questions, and at least three (3) days prior to the RFP due date deadline. The names of vendors submitting questions will not be disclosed.

MDOT is an equal opportunity employer and MDOT DBE firms are encouraged to apply. The participating DBE firm, as currently certified by MDOT's Office of Equal Opportunity, shall be listed in the Proposal

## MDOT FORMS REQUIRED AS PART OF PROPOSAL SUBMISSION

**5100D** – Request for Proposal Cover Sheet
**5100G** – Certification of Availability of Key Personnel
**5100I** – Conflict of Interest Statement

**(These forms are not included in the proposal maximum page count.)**

**Michigan Department of Transportation**

**SCOPE OF SERVICE**
**FOR**
**DESIGN SERVICES**

**CONTROL SECTION(S):** TBD

**JOB NUMBER(S):** TBD

**PROJECT LOCATION:**
Mackinac Bridge Authority, Mackinac County, MI

**PROJECT DESCRIPTION:**
This scope is to provide design for an ITS project, develop a final bid package based on 100% complete plans, provide cost estimate for construction, serve as MDOT representative, system manager, through construction phase, if necessary. Work involved in the design of the project consists of: Design, Provide Analysis, and Develop Letting Package.

Project is anticipated to be turned in for MDOT letting in March 2009.

The consultant will be responsible to scope the project, refine locations of equipment, develop plans to 100% complete, provide necessary geotechnical information, provide necessary survey work, and develop functional requirements. This project consists of all work related to design of the project. The system shall include Dynamic Message Signs (DMS) and communications infrastructure of which shall interface with the existing ITS monitoring software and equipment.

**PRIMARY PREQUALIFICATION CLASSIFICATION(S):**
Permanent Freeway Traffic Signing Plans

**SECONDARY PREQUALIFICATION CLASSIFICATION(S):**
Maintaining Traffic Plans and Provisions
Geotechnical Engineering Services
Intelligent Transportation Systems

**ANTICIPATED SERVICE START DATE:** January 15, 2009

**ANTICIPATED SERVICE COMPLETION DATE:** December 31, 2010

**DBE REQUIREMENT**: 0%

**MDOT PROJECT ENGINEER MANAGER:**
Greg Krueger
ITS Statewide Program Manager
Michigan Department of Transportation
8885 Ricks Road
Lansing, MI 48910
(517) 373-9479
kruegerg@michigan.gov

**BACKGROUND:**

Seven DMS signs in total are situated at and around the Mackinac Bridge to notify traffic about bridge conditions, weather closures and general bridge information. The current locations of all but one of these signs have proven very effective over their approximately 11 year life. However, consistent problems with communications, maintenance access, and the general degradation of the signs over time have incurred many costs and the current setup of sign communications and control is no longer practical. One of the signs, currently out of operation, has been deemed not necessary for replacement. The remaining six signs, three north of the bridge and three south of the bridge, are in need of replacement.

**CONSULTANT RESPONSIBILITIES:**

Complete a design of this project including, but not limited to the following:

- Provide conceptual layouts for the subject area with the scoping information attached in appendix A.
- Perform required design and functional technical specification writing to expand the ITS facilities in the project area. The proposed facilities shall include DMS, cabinets, communications infrastructure.
- Prepare required plans 100% complete which would include: typical cross-sections, details, functional requirements and specifications required for construction. MDOT shall provide any existing details and specifications applicable to the proposed work in electronic format.
- Compute and verify all plan quantities for the bid package which will include a breakdown.
- Prepare staging plans and special provisions for maintaining traffic during construction on Mackinac Bridge.
- Provide solutions to any unique problems that may arise during the design of this project.
- Provide bandwidth evaluation relative to the communications (permanent and temporary) to the Mackinac Bridge Authority as needed for operation.
- The consultant will develop component and acceptance tests and work with MDOT and the Mackinac Bridge to perform all tests.
- The consultant will contact all utility companies thru mailings to determine possible conflicts and incorporate the results from their investigation into their proposal.
- Prepare and incorporate all documents for E-Proposal Submittal.
- Meet with the MDOT Project Manager to review project, location of data sources and contact persons, and review relevant MDOT operations. The Consultant shall review and clarify project issues, data needs and availability, and the sequence of events and team meetings that are essential to complete the design by the project

plan completion date. Attention shall be given to critical target dates that may require a large lead time, such as geotechnical requirements, Railroad coordination requirements, utility conflict resolution, local agency meetings, etc.

- Maintain a Design Project Record which includes a history of significant events (changes, comments, etc.) which influenced the development of the plans, dates of submittals and receipt of information.

- P/PMS TASK 3360 - PREPARE BASE PLANS

- P/PMS TASK 3390 - DEVELOP THE CONSTRUCTION ZONE TRAFFIC CONTROL CONCEPTS

- The consultant shall identify the locations of any existing water main and/or sanitary sewer on the project.

- If watermains and/or sanitary sewers are present within the project limits, the CONSULTANT shall evaluate vertical elevations and design the depth of proposed fiber optic facilities so as not to be in conflict with the existing utility.

- P/PMS TASK 3530 - CONDUCT FOUNDATION STRUCTURE INVESTIGATION

- P/PMS TASK 3540 - DEVELOP CONSTRUCTION ZONE TRAFFIC CONTROL PLAN

- P/PMS TASK 3580 - DEVELOP PRELIMINARY PLANS

- P/PMS TASK 3590 - REVIEW PRELIMINARY PLANS (THE PLAN REVIEW)

- P/PMS TASK 3830 - COMPLETE THE CONSTRUCTION ZONE TRAFFIC CONTROL PLAN

- P/PMS TASK 3840 - DEVELOP FINAL PLANS AND SPECIFICATIONS

- P/PMS TASK 3870 - HOLD OMISSIONS/ERRORS CHECK (OEC) MEETING

- P/PMS TASK 5010 - CONSTRUCTION PHASE ENGINEERING AND ASSISTANCE

- The CONSULTANT may be required to provide Design Services during the construction phase of this project. If Construction Assistance is required, then a separate authorization for those services will be issued. The Consultant shall not be compensated for performing work due to errors or omissions.

- If excavation is required, submit the excavation locations which may contain contamination. Project Manager then can proceed in requesting a Preliminary Project Assessment (PPA).

- The Consultant shall be required to prepare and submit a CPM network for review and use for preparing the progress schedule for the project.

- The Consultant representative shall record and submit type-written minutes for all project related meetings to the MDOT Project Manager within two days of the meeting. The Consultant shall also distribute the minutes to all meeting attendees. MDOT will provide and distribute official meeting minutes for the Plan Review Meeting.

- Attend any project-related meetings as directed by the MDOT Project Manager.

- The MDOT Project Manager shall be the official MDOT contact person for the Consultant and shall be made aware of all communications regarding this project. The Consultant must either address or send a copy of all correspondence to the MDOT Project Manager. This includes all Subcontractor correspondence and verbal contact records.

- The Consultant shall contact the MDOT Project Manager whenever discoveries or design alternatives have the potential to require changes in the scope, limits, quantities, costs, or right-of-way of the project.

- The Consultant shall determine all potential utility conflicts with the proposed facility placement. The Consultant shall also, define solutions to the various utility conflicts and have them reviewed by MDOT before they are designed and placed on the construction plans.

- The Consultant is also responsible for determining the availability of electric service to the proposed facilities at the locations described previously. Any potential problems with utility electric service shall be brought to MDOT's attention as soon as they are known. The Consultant will be responsible for making contact with utility companies etc regarding the project for power or other conflicts as necessary.

- The MDOT Project Manager shall be the official MDOT contact person for the Consultant and shall be made aware of all communications regarding this project. The Consultant must either address or send a copy of all correspondence to the MDOT Project Manager. This includes all Subcontractor correspondence and verbal contact records.

- All plans, special provisions, estimates, and other project related items shall meet all MDOT requirements and detailing practices (i.e., format, materials, symbols, patterns, and layout) or as otherwise directed by the Project Manager.

- All plans, specifications, and other project related items are subject to review and approval by MDOT.

**MDOT RESPONSIBILITIES:**

- Schedule and/or conduct the following:
  - Project related meetings.
  - The Plan Review
  - Utility Meetings.
  - Final item cost estimates, as necessary.
  - Assist with packaging of plans and proposal for letting.

- Furnish Special Details and pertinent reference materials.

- Furnish prints of an example of a similar project and old plans of the area, if available.

- Coordinate any necessary utility relocations.

- Furnish diskette of file and instructions for the MDOT Stand Alone Estimator's Worksheet (SAEW).

**DELIVERABLES:**

FORMAT

Full size plans (cut size 24" x 36") and half size (cut size 11" x 18") consisting of plan sheets and profile sheets will be required. The project will require a ratio (scale) of **1:100 (English units).**

Other plan sheets that are required for this project shall be completed by the Consultant. These include, but are not limited to the following plan sheets:

- The title sheet. MDOT will provide a map of the area on a disk in our workstation format. If the map is not available, MDOT will provide a map that could be used. The Consultant shall be responsible for any revisions to the title sheet and the title sheet and map shall meet MDOT format and layout guidelines.

- Note Sheet.

- Typical Cross-Sections. *

- Project specific Special Details. *

- Construction staging and traffic control plans.

- Witness and benchmark sheet(s).

- Electronic Files for each to be provided.

- Plan sheets may require larger scale depending on level of detail needed.

**TRAFFIC CONTROL AND MDOT PERMITS**

The Consultant shall be responsible for all traffic control required to perform the tasks as outlined in this Project Scope of Design Services.

The Consultant shall be responsible for obtaining up to date access permits and pertinent information for tasks in MDOT Right of Way (ROW). This information can be obtained through Joe Rios, Utilities/Permits Section, Real Estate Division at (517) 241-2103.

**UTILITIES**:

The Consultant shall be responsible for obtaining from MDOT and showing on the plans the location and names of all existing utilities within the limits of the project. In the course of resolving utility conflicts, the Consultant shall make modifications to the plans or design details and provide assistance as directed by the MDOT Utility Permits Engineer and/or Project Manager. The Consultant shall attend any utility meetings called to ensure that the concerns are addressed on the plans involving utilities. The Consultant shall assist in the review of utility permit requests to ensure compatibility with the project. The consultant shall provide for the staking of various proposed facilities so as to locate potential utility conflicts and aid in the completion of utility relocation plans for and private utility companies.

**SCHEDULE:**

The start date for the consultant services will be immediately upon notice to proceed (NTP). The duration of the services will be at the discretion of MDOT project manager.

The Consultant shall provide at the kick off meeting a detailed schedule of target dates for each step of the design.

**PROJECT MANAGEMENT:**

This project will require close interaction and good communication between the consultant and MDOT. If there are any major deviations from the original scope of this assignment, these changes must be documented and jointly approved by the consultant and MDOT.

The selected consultant shall provide all necessary project management services, including monthly and quarterly progress reports, developing and maintaining a project schedule, and providing invoices in a timely manner.

Consultants should provide a description of their management team for this project and list all key personnel responsible for the deliveries of this RFP.

**STATUS REPORTS/ MEETINGS:**

There will be periodic, regular meetings between MDOT representatives and the selected consultant to review work product, and to communicate progress, issues, ideas, and expectations.

The selected consultant shall provide copies of all project reports, correspondence, meeting announcements, and meeting minutes which shall be delivered by email to the

MDOT Manager. The consultant shall provide the minutes of all meetings attended. These shall be distributed by email to the MDOT Project Manager.

**WEEKLY PROGRESS REPORT**

The Consultant Project Manager shall submit a weekly project progress report to Michele Mueller, Project Manager. The weekly progress report shall include status of the design for each corridor. The schedule supplied at the kick off meeting shall be updated with completed and future key dates. If the schedule is showing the contract behind schedule the consultant shall provide a detailed method to insuring the completion date will be met.

**PROJECT DOCUMENTATION:**

All documentation and reports shall be delivered in the current version of Microsoft Word being used by MDOT. All documentation delivered shall be clear, concise, complete, and in compliance with standards required by the MDOT Project Manager.

**CONSULTANT PAYMENT – Actual Cost Plus Fixed Fee:**

Compensation for this project shall be on an **actual cost plus fixed fee** basis. This basis of payment typically includes an estimate of labor hours by classification or employee, hourly labor rates, applied overhead, other direct costs, subconsultant costs, and applied fixed fee.

All billings for services must be directed to the Department and follow the current guidelines. The latest copy of the "Professional Engineering Service Reimbursement Guidelines for Bureau of Highways" is available on MDOT's website. This document contains instructions and forms that must be followed and used for billing. Payment may be delayed or decreased if the instructions are not followed.

Payment to the Consultant for services rendered shall not exceed the maximum amount unless an increase is approved in accordance with the contract with the Consultant. Typically, billings must be submitted within 60 days after the completion of services for the current billing. The final billing must be received within 60 days of the completion of services. Refer to your contract for your specific contract terms.

Direct expenses, if applicable, will not be paid in excess of that allowed by the Department for its own employees in accordance with the State of Michigan's Standardized Travel Regulations. Supporting documentation must be submitted with the billing for all eligible expenses on the project in accordance with the Reimbursement Guidelines. The only hours that will be considered allowable charges for this contract are those that are directly attributable to the activities of this project.

The use of overtime hours is not acceptable unless prior written approval is granted by the MDOT Region Engineer/Bureau Director and the MDOT Project Manager. Reimbursement for overtime hours that are allowed will be limited to time spent on this project in excess of forty hours per person per week. Any variations to this rule should be included in the priced proposal submitted by the Consultant and must have prior written approval by the MDOT Region Engineer/Bureau Director and the MDOT Project Manager.

The fixed fee for profit allowed for this project is 11.0% of the cost of direct labor and overhead.

APPENDIX A

**Mackinac Bridge Authority**
**Dynamic Message Sign Replacement**
**Mackinac County, MI**

## EXECUTIVE SUMMARY

### Recommended Replacement Option

The recommended option for replacement includes six new Dynamic Message Signs, five of which would be mounted on the existing roadside steel support structures. The remaining sign, currently mounted on a full-span overhead truss, is recommended to be removed along with the existing truss, the furnish and install of a new truss on the existing foundation, the re-attachment of the existing static signs and the replacement of existing DMS with a new DMS. Additionally, a new uniform 900 MHz communications system and operator workstation is recommended.

The initial construction cost estimate for this option is **$701,200**. (This cost is in 2008 dollars and does not include PE , System Manager and CE.) PE costs are estimated at **$100,000** and System Manager and CE costs are estimated at **$98,200**. The total project estimate is **$899,400**.

### Project Description

Seven DMS signs in total are situated at and around the Mackinac Bridge to notify traffic about bridge conditions, weather closures and general bridge information. The current locations of all but one of these signs have proven very effective over their approximately 11 year life. However, consistent problems with communications, maintenance access, and the general degradation of the signs over time have incurred many costs and the current setup of sign communications and control is no longer practical. One of the signs, currently out of operation, has been deemed not necessary for replacement. The remaining six signs, three north of the bridge and three south of the bridge, are in need of replacement.

The posted speed limit is 70 mph along NB and SB I-75 and 55 mph along US-2.

### Sign, Communications, and Electronics Condition

These signs are connected to the Mackinac Bridge Authority's control center via three different communications mechanisms – telephone service drops (plain old telephone system, or "POTS"), 900 MHz wireless radios, and hard-wired serial data line. The two remote sites north of the bridge utilize POTS, which incur a monthly fee, the sign north of the bridge at the plaza (for travelers entering the bridge toll plaza) utilizes an RS-485 line connected directly to the control center, and the three signs south of the bridge utilize 900 MHz radios.

Separate vendors require separate control software packages and operating platforms, and hence require multiple screens and computers. MS-DOS is required for one software package and Windows for the other, causing operating complications and narrowing interfacing options.

Lack of lightning protection has left signs in need of major repair after being struck by lightning. Several of the signs have been struck multiple times and replacement parts are no longer available.

### Structural Condition

Six DMS support structure sites were visited. Measurements were taken, the conditions of the structural elements were evaluated, and photographs were taken. The condition of the DMS support structures were

in good condition with no visible signs of corrosion, missing or loose bolts in the bolted connections, cracking, etc.

Calculations were performed to determine the flexural moments and corresponding flexural stresses in the 'W' shaped columns.

The DMS support structure sites with the 'W' section column configuration do not need to be replaced or retrofitted to support the proposed DMSs. According to the strength and fatigue requirements in the AASTHO Luminaries Code, columns of the DMS support structures are defined as structurally adequate. The maximum design life of the DMS support structures shall not exceed 31 years. The DMS support structure consisting of the overhead truss was not evaluated.

**Site Issues**

Vertical Clearance
The signs mounted on the roadside do not overhang traffic, and therefore there is no vertical clearance requirement. The overhead truss site appears to be constructed to MDOT road design guidelines with clearance of 16'-6" or greater.

DMS Visibility
During the site visit there appeared to be adequate site distance in order for motorists to view the signs for a minimum of 1000 feet upstream of the sign locations.

Signs (static)
There appear to be no conflicts with other signs or signing structures.

Utilities
Existing utilities and infrastructure will be utilized on the five roadside sides; therefore, no utility work will be required and thus no utilities conflicts. As to the new truss that is proposed, HNTB was advised by bridge personnel that no utility conflicts appear to exist; however, the future designer should be required to confirm.

**Project Contact Person:**

| | |
|---|---|
| MBA: | Michael Litzner, CFO |
| MDOT: | Greg Krueger, Statewide ITS Director |

## 1.0 FIELD SITE REVIEW FINDINGS

A site visit was conducted in Mackinaw City, Michigan for the Mackinac Bridge Authority. On 9/18/08, six DMS sites were visited along with the control center located at the Mackinac Bridge Authority administration office. Measurements were taken, the conditions of the structural elements were evaluated, and photographs were taken.

Descriptions for DMS Support Structures
The configuration of five of the six DMS support structures consisted of two to four columns, depending on the site, two horizontal chords, vertical struts at some sites, and other structural elements to connect the DMS to the support structure. Figure 1 shows the configuration of the structural elements at the five DMS support structure sites with 'W' shaped columns. The names of the DMS sites in Figure 2 are how the sites are differentiated from one another. The sixth DMS support structure was an overhead truss similar to the MDOT Standard Type 'C' Truss. The overhead truss was not evaluated in this phase of the project and is not discussed in this report.

A preliminary assessment indicated the columns were the most "critical" structural members in the DMS support structure. Structural elements defined as "critical" were evaluated with hand calculations of varying degrees of detail. The columns consisted of 'W' shaped steel sections. The vast majority of the calculations performed to evaluate the DMS support structure were for the 'W' shaped column members and the base plate connection. A typical base plate connection is shown in Figure 2.

The site visits revealed the foundations consisted of uncased and cased drilled shafts. The Mackinaw Bridge Authority verbally communicated information to HNTB regarding the degree of favorable soil conditions for the drilled shafts. It is understood that the drilled shafts bear on bedrock and are approximately 8 ft long at each location. Based on this information, the drilled shafts were not categorized as "critical" structural members requiring further evaluation and, therefore, calculations were not performed for the drilled shafts.

The portion of the support structure attached to the DMS consisted of horizontal, aluminum angles and vertical, aluminum 'W' sections at two DMS support structure sites, and horizontal, aluminum 'Z' shaped channels at three DMS support structure sites, depending on the site location. The aluminum angles, 'W' shapes, and 'Z' shaped channels were not categorized as "critical" members.

Description of Calculations

Calculations were performed to determine the flexural moments and corresponding flexural stresses in the 'W' shaped columns. The axial stresses were small and neglected in the calculations. The flexural stresses were compared to the applicable requirements in the 4th Edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals with 2003 Interims (referred to as the AASHTO Luminaries Code below) and the 17th Edition of the AASHTO Standard Specifications for Highway Bridges. The strength of the columns were evaluated with the vertical, eccentric, dead load of the DMS and an equivalent static pressure simulating a wind gust, acting perpendicular to the front surface of the DMS. The fatigue performance of the columns was evaluated with an equivalent static pressure simulating a natural wind gust, acting perpendicular to the front surface of the DMS. The dead load of the DMSs that will replace the existing DMSs is 1.32 kips and have a nominal width of 21 ft – 6 in., a nominal height of 5 ft – 11 in., and a nominal depth of 1 ft – 2 in.

The different column heights were used to calculate the flexural stiffness coefficients at sites with a considerable ground slope. The distribution of the loads among the columns was based on the relative stiffness of adjacent columns. At the base of the columns, the column rotations and column translations were assumed to be completely restrained in any direction. At the connection of the column and the bottom chord, the rotation of the column was assumed to be restrained about an axis perpendicular to the front face of the DMS (flexure about the weak axis of for a column) and an axis parallel to the column's longitudinal axis (torsion about the column). The translation of the column was assumed to be restrained in the direction of the chord's longitudinal axis.

The wind load was a function of the AASHTO Luminaries Code variables titled, "wind importance factor" and "drag coefficient;" as well as other variables. The selection of the magnitude of the two variables sited above may be open to interpretation. The "wind importance factor" depends on the design life of the structure. To the best of HNTB's knowledge, the oldest of the five, existing DMS support structures is 11 years and the design life of a new DMS is 20 years. The design life of the support structure based on this information is 31 years. This corresponds to a "wind importance factor" of 0.925. The value was linearly interpolated from "wind importance factor" values in Table 3-2 of the AASHTO Luminaries Code. If it is desirable for the design life of the DMS support structure to accommodate DMSs in the future after the proposed DMS is replaced, a higher "wind importance factor" must be used and the DMS support structure calculations show the AASHTO Luminaries Code is not satisfied.
A drag coefficient of 1.7 was used for the DMS when the wind load was determined. This value was provided in Note (7) in Table 3-6 of the AASHTO Luminaire Code. A portion of the note states, "A value of 1.7 is suggested until research efforts can provide precise drag coefficients." This portion of the note indicates the value of 1.7 may be conservative.

The dimensions of the columns measured during the 9.18.08 site visits indicated the columns are close to a W8x18 section. Additionally, the 2nd-4th sheets of the plans in Appendix A reference W8x18 sections. However, a W8x13 was referenced on the plan sheet in Appendix A titled, "Steel Column." The more conservative section properties for a W8x13 were used in the calculations for the steel columns.

Notes (8) and (9) on the plan sheet in Appendix A titled, "Steel Column" provide the option of using a steel material with a yield stress of 36 ksi or a yield stress of 50 ksi. To the best of HNTB's knowledge, it may be difficult to obtain mill certificates from the fabricator that produced the 'W' sections for the columns in the DMS support structures. Therefore, the calculations were performed first by assuming the yield stress of the steel material was 36 ksi. The calculations were repeated assuming the yield stress of the steel material was 50 ksi. The results of both sets of calculations were examined.

Table 1 shows the maximum strength stress ratio and maximum fatigue stress ratio at each DMS support structure site. The yield stress for the steel material was assumed to be 36 ksi. Table 2 presents similar results for calculations performed with a steel material with a yield stress of 50 ksi. The stress ratio is the ratio of the calculated flexural stress from the applied dead load and wind load to the allowable flexural stress calculated using the AASHTO Luminaries Code. Stress ratios less than 1.0 indicate the columns at the DMS support structure site are adequate for the strength or fatigue requirements.

Table 1: Stress Ratios for DMS Support Structure Sites Assuming $F_y$ = 36 ksi

| Site Name | Maximum Stress Ratios | |
|---|---|---|
| | Strength | Fatigue |
| I-75 | 0.93 | 0.30 |
| US-2 | 0.61 | 0.20 |
| Plaza | 0.78 | 0.26 |
| South | 0.78 | 0.26 |
| US-23 | 1.01 | 0.33 |
| MAX | 1.01 | 0.33 |

Table 2: Stress Ratios for DMS Support Structure Sites Assuming $F_y$ = 50 ksi

| Site Name | Maximum Stress Ratios | |
|---|---|---|
| | Strength | Fatigue |
| I-75 | 0.88 | 0.30 |
| US-2 | 0.44 | 0.20 |
| Plaza | 0.57 | 0.26 |
| South | 0.56 | 0.26 |
| US-23 | 0.75 | 0.33 |
| MAX | 0.88 | 0.33 |

## 2.0 REPLACEMENT OPTIONS

After years of operating these DMS, the MBA has developed the following list of expectations for new and replacement signs:

1. Upgrade of lightning protection and surge protection within the signs and within the sign control cabinets.
2. Accessible test points for electronic fault finding in each sign.
3. Acceptable quality of communications including room for future developments.
4. Ease of access to electronics for maintenance.
5. Each replacement should remain with the same message set, location and size.
6. Re-use the current foundation, truss and 900 MHz wireless communications system.
7. Full control of all signs within a Windows based software.

Dependent upon terrain and general location the following are expectations for the replacement of specific
signs;

1. DMS I-75 (north) – structure with built in ladder, move electronics.
2. DMS US-23 – achieve an acceptable quality communications link.
3. DMS Overhead – replacement of existing truss utilizing existing foundation, furnish and install DMS and the addition of a cabinet containing sign controller, communications, lightning and surge protection, cabinet power supply and UPS.

After visiting the control room and each sign site, it is evident that improvements to these signs would convey a direct positive effect on maintenance safety, sign integrity and use of sign control software. These recommendations have been based on considering problems expressed by the MBA staff and the experience of current DMS technology advancements.

Dynamic Message Signs

All signs need to have rear access to internal electronics and the structure should comprise a rear platform with an optional ladder. It is recommended that all high maintenance equipment i.e. controller, power supplies, etc. reside in the DMS cabinet.

A full matrix display would give more versatility with messages while still allowing use of the current message set. This will open the future potential for a newer message set and can even allow three lines of smaller text for low speed areas. If required, the current message set can be compared with the standard character size and the sign matrix can be calculated.

Replacement signs should all come from the same vendor, and the use of vendor supplied software is recommended due to the simplicity of control needed. This or any software must also conform to the National Transportation Communications for ITS Protocol (NTCIP) standards to allow future integration with other NTCIP signs, software, and equipment. Conforming to this recommendation provides one form of communications protocol throughout and using a single vendor ensures the majority of parts will be interchangeable.

Lightning protection for both signs and their cabinets is highly recommended.

Communications

Preferably, communications to all sites should be kept (for the south sites) and converted to wireless on the 900 MHz frequency. All connections are then owned by MBA, removing the ongoing monthly costs and dependency upon the telephone utility for communications. This would also allow for ease of maintenance and parts for each communications path.

In cases where wireless communications are not possible, a cellular modem relay would be the recommendation. This, however, would introduce a monthly cost.

Structures

The DMS support structure sites with the 'W' section column configuration do not need to be replaced or retrofitted to support the proposed DMSs. According to the strength and fatigue requirements in the AASTHO Luminaries Code, columns of the DMS support structures are defined as structurally adequate. The maximum design life of the DMS support structures shall not exceed 31 years. The structural performance of the support structures are also based on the assumptions and descriptions provided in the sections above. The DMS support structure consisting of the overhead truss was not evaluated.

MICHIGAN DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
**DYNAMIC MESSAGE SIGN, SMALL**
**DYNAMIC MESSAGE SIGN, SMALL, FND AND STRUCTURE**



**a. Description.** This work consists of the furnishing of a full matrix LED arterial display type Dynamic Message Sign (DMS). The DMS will be permanently mounted, accessible from the front or rear of the sign (site specific as depicted in the Plan Set), and capable of displaying alpha-numeric characters in each of one, two or three distinct rows of characters, as defined and depicted within the Project Plan Set. The Contractor is responsible, and must submit to the Project Engineer for approval prior to construction, all geotechnical investigation, site survey activities including the furnishing of a final cross section and the design of the DMS foundation and structure sealed by a Michigan Registered Engineer and meeting the mounting requirements of the individual sign and the DMS vendor mounting parameters. Each DMS site location will consist of, but not be limited to, the DMS and an ITS Cabinet (paid under another pay item). The ITS Cabinet will contain all necessary ITS network communications equipment, all appurtenances in support of the communications equipment, distributed power, UPS and surge suppression and grounding for the cabinet and its internal devices. This work must be done in accordance with the current Michigan Department of Transportation Standard Specifications for Construction, except as modified.

1. General.
   A. Furnish, install, integrate and test all equipment and components necessary to provide full and complete ITS functionality in all respects, without additional expense to the Department.
   B. Furnish, test and deliver the DMS as stipulated by the Engineer.
   C. Demonstrate the DMS functions and meets the requirements in these specifications.
   D. Position DMS with message facing oncoming traffic and align in such a manner as to maximize message visibility.
   E. Provide temporary blocking to keep the DMS off the ground, sign power and assure the DMS is secure while in storage.
   F. Provide all equipment required for testing of the DMS and DMS components contained within this procurement as an appurtenance to the electronic equipment included within the project at no additional cost to the Michigan Department of Transportation (MDOT).

2. Requirements of Regulatory Agencies.
   The compliance with the latest edition of the following codes or standards is required:
   A. Institute of Electrical and Electronic Engineers (IEEE).
   B. American Association of State Highway and Transportation Officials (AASHTO) including, but not limited to:
      (1) Standard Specifications for Highway Bridges, 17th Edition with interim updates
      (2) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 4th Edition with interim updates
   C. National Transportation Communications for ITS Protocol (NTCIP).
   D. American Society for Testing and Materials

E. American National Standards Institute Standard C2 (ANSI).
F. American Society of Testing and Materials' (ASTM).
G. National Electric Code (NEC).
H. American Society of Civil Engineers (ASCE).
I. American Institute of Steel Construction (AISC).
J. Institute of Electrical and Electronic Engineers (IEEE) 802.3.
K. National Electrical Manufacturers Association (NEMA).
L. National Electrical Manufacturers Association (NEMA) TS4.
M. AASHTO/NSBA Steel Bridge Fabrication Guide Specification.
N. AASHTO/NSBA Steel Bridge Design and Detailing Guidelines.
O. National Cooperative Highway Research Program (NCHRP).

If codes, standards or the requirements are in conflict with a special provision; the stricter standard or requirement will govern the Contractor. The Engineer will be the final authority in the resolution of any and all conflicts relating to codes and standards versus special provisions.

3. DMS Vendor Experience and Qualifications.
MDOT requires that the Contractor proposed a DMS Vendor for this project that has a positive track record for delivery of functional and reliable DMS and the very highest levels of post-delivery support and service. In keeping with this desire for a proven DMS vendor the Department reserves the right to contact references to verify all submitted past performance information and to assess the quality of the Vendor based on the results of the verification and assessment.

As an integral portion of the submittal process, submit to MDOT the following proposed DMS vendor information (see Table 1), said information and references must be a representation of a single corporate entity and that corporate entity alone.

**Table 1: Vendor Information**

| Number of References | Type of Reference | Minimum Reference Description |
|---|---|---|
| 8 | Project | • One or more Arterial Type LED DMS<br>• DMS used by State DOT, Municipal or Toll Agency<br>• Within past five years |
| 1 | Total Projects | • A minimum of 25 full matrix arterial type LED DMS in continuous use for at least two years |
| 8 *(one for each project above)* | Customer | • Project name<br>• Customer name<br>• Customer contact person name<br>• Current customer contact person phone and e-mail |
| 1 | Financial | • Financial resources statement (Bank Reference and DUNS Report minimum)<br>• The financial ability to provide long-term support |
| 1 | Standards | • Statement with independent concurrence regarding NTCIP Standard compliance |
| 1 | Demonstration | • The Vendor agrees to provide DMS demonstration at MDOT site, upon request |

| | | |
|---|---|---|
| 1 | Post Award Verification | • The Vendor agrees to conduct factory testing as required within this Special Provision, required burn-in of each DMS prior to shipment and final acceptance testing on-site post installation<br>• Vendor provides proof of compliance from independent sources regarding:<br>o NEMA Standards Publication TS4, Hardware Standards for Dynamic Message Signs (DMS);<br>o NEMA Requirements – Section 2, Environmental Requirements<br>o UL 48 Standard for Electric Signs<br>o UL 50 Enclosures for Electrical Equipment<br>o UL 1433 Standard for Control Centers for Changing Message Type Electric Signs |

4. DMS Testing and Acceptance Requirements.
Conduct such tests as necessary to assure each DMS meets the requirements and specifications. The Engineer and/or MDOT Representative reserve the right to witness and /or verify, or to appoint a representative to witness all product testing during manufacture of the DMS.

A. Manufacturing Process Testing and Burn-in.
Furnish to the Engineer for approval a complete DMS Vendor manufacturing process testing and Quality Control and Assurance Plan. This Plan must include all appropriate tests from the component level to sign assembly completion, including a required 96-hour burn-in of each DMS.

B. Factory Acceptance Testing (FAT).
Furnish a Factory Acceptance Test (FAT) at no additional cost to MDOT. The Contractor will bear all travel expenses including, air fare, hotel and meals for up to three representatives of MDOT for the FAT and product testing event. The FAT will be performed at the DMS Vendor's manufacturing. FAT is required prior to installation of any DMS. FAT tests include, but are not limited to:

(1) NEMA 250 Water Spray Test with no visible signs of water leakage through any of the sign housing seams
(2) Proof of the 96-hours of continuous operation of the FAT DMS
(3) Post FAT, the Engineer will audit and accept all burn-in test logs for each DMS prior to that DMS shipping from the factory
(4) The physical verification through inspection by the Engineer and/or MDOT Representative that the DMS meets the Special Provision and the approved submittal and shop drawings

C. Post Delivery Testing and Operation.
Upon delivery of each DMS to the location designated by the Department and as shown on the project plan sheets, provide permanent power, within 72 hours of delivery, for the demonstration of the DMS functions in accordance with the requirements and specifications and has not been damaged during shipment. Maintain the DMS's power feed from the day of delivery to final acceptance and thereby protecting the interior electronics within the DMS from environmental degradation.

(1) Post-delivery Test Plan: Develop and submit to the Engineer for approval a post-delivery test plan. The test plan must demonstrate the complete functionality and

integrity of the DMS after shipment and post delivery. The plan will describe test procedures, detail features being tested and the expected values that demonstrate DMS compliance

(2) Testing Schedule: All DMS will be tested in accordance with the Post Delivery Test Plan

D. Reporting Requirements.

(1) Submit Vendor and third-party reports verifying testing procedures, testing dates and testing results. The report will document comparison of test results to the specifications detailed herein. The report will clearly identify any failure to conform to the specifications

(2) Failure to conform to testing procedures will be considered a defect and the equipment and thereby be subject to rejection by the Engineer and/or MDOT Representative. Rejected equipment may be offered again for a retest, provided that complying test procedures have been corrected and the DMS retested by the vendor or third party and evidence thereof has been submitted to the Engineer and/or the MDOT Representative

(3) Failure of any DMS to conform to the specifications will be considered a defect and the DMS is thereby subject to rejection by the Engineer and/or the MDOT Representative. Rejected equipment may be offered again for a retest, provided that all non-compliances have been corrected and retested by the vendor and evidence thereof has been submitted to the Engineer and/or Representative

(4) Final FAT and Product Test reports showing complete compliance with specifications must be submitted and approved by the Engineer before the Contractor releases the DMS for shipment

(5) Submit structure, Vendor, and third-party reports verifying testing procedures, dates and results. The report will document comparison of test results to the specifications detailed herein. The report will clearly identify any failure to conform to the specifications

(6) Failure of any structure to conform to the MDOT minimum specifications will be considered a defect and the DMS structure is thereby subject to rejection by the Engineer and/or the MDOT Representative. Rejected equipment may be offered again for a retest, provided that all non-compliances have been corrected and retested by the vendor and evidence thereof has been submitted to the Engineer and/or Representative

(7) Submit for the Engineer's approval a written installation plan of procedures to follow when excavating the hole, placing the concrete, and monitoring the concrete placement. Submit the installation plan at least 14 calendar days before constructing the drilled shafts, if required. Include the following information:

(a) Details of the sequence proposed for the overall drilled shaft construction operation

(b) Procedures for maintaining correct horizontal and vertical alignment of the excavation

(c) If using a casing, method to advance the casing

(d) If using a temporary casing, details of the methods to extract the temporary casing and to maintain the concrete slump to keep concrete workable by adding admixtures such as retarders or super-plasticizers

(e) If using drilling slurry, details of the methods to mix, circulate, and de-sand the slurry

(f) Details of methods to clean the shaft excavation prior to concrete placement

(g) Details of reinforcement placement including support and centralization methods
(h) Details of concrete placement including proposed operational procedures for free fall, tremie, and/or pumping methods
(i) A list of proposed equipment to be used such as cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, slurry pumps, tremies, concrete pumps, casings, etc
(j) Acceptance of the installation plan will not relieve the Contractor of the responsibility for obtaining the required results

E. Final inspection and acceptance of the DMS:
(1) Submit the Product Testing report for approval
(2) Submit the FAT report for approval
(3) Deliver the DMS to a site designated by the Department
(4) Deliver proof and verification of the DMS continuous operation post delivery
(5) Submit the reports documenting the results of the post delivery test for approval
(6) Provide a factory trained Technician who will be present when the DMS is installed on its designated support structure and integrated with the ITS Cabinet, power supply and communication network. The Technician will verify that the installation is in full compliance with the Vendor's installation specifications and certify that the DMS Vendor's Warranty is in full force and effect after the DMS and all appetencies are installed and fully operational

**b. Materials.**

1. The Source of Steel and Iron.
All steel and iron materials permanently incorporated in this project must be produced in the States, Territories, or Possessions of the United States, unless the materials are no longer produced in the United States. These materials will include steel, steel products, and products that include steel components.
A. All manufacturing processes, including application of a coating, for these materials and products must have occurred within the States, Territories, or Possessions of the United States.
B. Coating includes all processes which protect or enhance the value of the material to which the coating is applied. This specification allows the minimal use of foreign steel materials on the project, if the total invoice cost of the materials permanently incorporated in the project does not exceed one-tenth of one percent of the total contract cost or $2,500, whichever is greater.
C. For purposes of this specification, the total cost is that shown to be the total value of the steel products and materials as they are delivered to the project. Written certification of compliance will be submitted by the DMS Vendor to the Engineer.

2. DMS Functional Requirements.
The Concept of Operations defines the minimum sign functionality in each of the following areas. The Contractor must demonstrate, to the satisfaction of the Engineer, compliance with each of these functional requirements.
A. The DMS must be capable of receiving message commands and control from the MDOT designated Traffic Management Center (TMC) or other operation center/s using NTCIP Protocol central system software.

B. The DMS will provide sign and communication maintenance and diagnostic information to the operators at the TMC or other operation center/s as determined by the Department.
C. The DMS will be available for use for traffic and incident management regardless of environmental conditions.
D. The DMS must be capable of delivering back to the operator accurate displayed message verification by way of “what-you-see-is-what-you-get” or known as WYSIWYG.
E. Command and Control Requirements.
F. MDOT will communicate with the DMS using NTCIP compliant software. All features and capabilities of the sign must be controllable through the MDOT NTCIP compliant software.
G. Maintenance and Diagnostics Detection and Reporting Requirements.
H. The DMS is to be capable of detecting faults with any component within the DMS Housing and DMS Cabinet and reporting those faults to the appropriate MDOT operation center. The diagnostic report will clearly describe the nature of the problem, the components involved, and any other information necessary to facilitate timely and efficient maintenance.
I. General Requirements.
   (1) All electrical components must operate on 120/240 volt 60 Hz electricity, or Contractor must provide appropriate DC conversion for any equipment requiring DC power
   (2) The DMS vendor is to utilize identical and completely interchangeable components within all DMS furnished under this contract
   (3) The DMS vendor and the Contractor are to utilize equipment designed to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance
J. DMS Environmental Requirements.
   (1) The DMS display will be enclosed in either a front access or rear access housing
   (2) The DMS enclosure, components, heating and ventilation and workmanship must be of new components, corrosion resistant and adequate to assure full sign functionality and durability in the Michigan environmental conditions
   (3) All field equipment must perform to the minimum environmental and sign hardware requirements specified in NEMA TS2. Currently these specifications require a temperature range of -29.2°F to 165° F and a humidity range of 0 percent to 95 percent relative non-condensing
   (4) All outdoor enclosures must resist hose-directed water per NEMA 250 – Class 3R requirements
   (5) Install all the field equipment to be capable of operating in all weather conditions and withstand a wind load of 90 mph without permanent damage to sign, sign structure, mechanical equipment, or electrical equipment
   (6) All connections, internal or external to the DMS enclosure must be watertight
   (7) If the DMS is subjected to temporary storage, the DMS will be protected from impacts and intrusion from animals, insects, water, or other potentially damaging situations
K. Messaging Requirements.
   (1) The DMS Static RAM will be capable of storing and displaying pre-worded messages, message sequences and message lists. Message wording, language and formatting will comply with applicable NTCIP standards

(2) The DMS will be capable of displaying user created messages not contained within the message library
(3) The DMS Vendor must supply the most current version of NTCIP. Additionally the Department, at its discretion, can require at no additional cost to the Department one firmware upgrade during the warranty period

L. Display Requirements.
(1) The DMS will be a LED full matrix sign
(2) The DMS display will be comprised of Light-emitting diodes (LED) formed into pixels
(3) Each character will be comprised of a variable-size font, nominally seven pixels tall and five pixels wide. This can be considered the standard font; however the sign control software must have the ability to adjust the height and width of characters.
(4) The full matrix DMS will be capable of displaying a minimum either 9 inch or 12 inch characters in one of several configurations. The 12 desired configurations are listed in Table 2 below:

**Table 2: DMS Configurations**

| Character Size | Lines/ Characters/Line | Minimum Sign Dimensions (Inches) |
|---|---|---|
| 9 inch | 2/10 | 34H X 98W |
| 9 inch | 2/16 | 34H X 140W |
| 9 inch | 2/21 | 34H X 183W |
| 9 inch | 3/10 | 55H X 98W |
| 9 inch | 3/16 | 55H X 140W |
| 9 inch | 3/21 | 55H X 183W |
| 12 inch | 2/10 | 45H X 132W |
| 12 inch | 2/16 | 45H X 189W |
| 12 inch | 2/21 | 45H X 247W |
| 12 inch | 3/10 | 74H X 132W |
| 12 inch | 3/16 | 74H X 189W |
| 12 inch | 3/21 | 74H X 247W |

(5) Each character is to be separated by the minimum width of one unlit pixel column
(6) Each line of characters is to be separated by the minimum height of two unlit pixel columns
(7) Minimum DMS visibility distance is based on character size. For 9 inch characters minimum required visibility will be 450 feet, and for 12 inch characters the minimum required visibility will be 600 feet

M. Foundation and Structure
(1) The structure must conform to all the individual sign requirements and parameters as specified by the sign vendor
(2) The structure must conform to AASHTO wind loading requirements
(3) The structure fatigue and vibration design must conform to NCHRP 10-38

N. Mounting Requirements.
(8) DMS must be furnished with multiple lifting eyes or marked equipment hoisting points. Lift eyes will be designed in such a way as not to negatively impact the aesthetics, water tightness or functionality of the sign. If the lifting eyebolts are removed from the DMS after installation, bolts will be supplied to plug and seal the holes to prevent water from entering the DMS housing
(9) The DMS vendor must supply all mounting hardware for each sign to include but not limited to, “Z” bars, brackets, connectors, clamps, etc.

(10) When the DMS will be mounted to a legacy structure, as specified by the Engineer, the mounting hardware will conform to that of the legacy structure. An Engineer, registered in the State of Michigan, must review the legacy structure and verify whether the structure is satisfactory for mounting the new DMS

O. Communication Requirements.
(1) All DMS components must be capable of specified NTCIP compliant communications
(2) All data detected by the DMS (e.g., diagnostic data) is transmitted to the Communications Network and all data required by the DMS is received by the DMS from the Communications Network

P. Surge Protection.
(1) The DMS surge protection system will have a surge capacity of 10kA, providing protection between Line to Neutral, Line to Line, Line to Ground, and Neutral to Ground
(2) The surge protection system will reset automatically and be maintenance free
(3) Ambient temperature rating of the surge protection system must be a minimum of -29.2ºF to +165ºF

3. ITS Cabinet (Under Another Special Provision).

4. Equipment Specifications
Comply with these specifications in addition to the above requirements. The specifications are intended to supplement and clarify the functional requirements. Bring to the Engineer's attention any apparent conflict between the requirements and specifications and request clarification.

A. DMS Specifications.
(1) DMS Housing
(a) The housing will protect internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards, as described in *NEMA Standards Publication 250-1997, Enclosures for Electrical Equipment (1000 Volts Maximum)*
(b) The DMS housing bottom side will contain small weep holes for draining any water that may accumulate due to condensation
(c) Weep holes and ventilation/exhaust hoods will be screened to prevent the entrance of insects and small animals
(d) No internal electrical wiring or internal electrical components of any type (fans, power supplies, transformers, LED display modules, circuit boards, surge suppression devices, fuses, relays, power and signal termination panels, utility outlets, and other electrical components) will be located within 4 inches (102 mm) of the DMS housing floor. This will prevent short circuits from occurring, in the event of internal water buildup. The only allowable exception to this requirement will be the bottom-facing photo sensor assembly, which will be insulated to prevent water-related short circuits
(e) The DMS housing must be constructed to present a clean, neat appearance
(f) A Professional Engineer registered in the Michigan will analyze the DMS structural design and will certify that the DMS:
(i) Will withstand a wind velocity of 90mph
(ii) Will support a front face ice load of 4 pounds per square foot
(iii) Complies with the fatigue resistance requirements of *NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports*

(iv) The DMS manufacturer will include a signed and sealed copy of this P.E. certification, including all supporting calculations, with the pre-build technical submittal

(g) The DMS housing will provide safe and convenient access to all modular assemblies, components, wiring, and other materials located within the DMS housing. All LED display modules and internal components will be removable and replaceable by a single technician

(2) Front Face Construction.

(a) The DMS front face will be constructed with multiple LED display modules, each of which support and protect the display matrix. Seams that separate adjacent LED display modules will be sealed. LED display modules will not be welded to the DMS housing

(b) Front face LED display modules will provide a high-contrast background for the DMS display matrix. The front of each LED display module will be semi-gloss black for the LED pixels. The DMS front face border will be covered with a shroud that is 2/3 the width of the minimum character height of the display. The shroud will be formed from 0.090 inch aluminum alloy 5052-H32 sheeting. DMS shroud will be coated with semi-gloss black polyvinylidene fluoride (PVDF)

(c) In the presence of wind, rain and snow, the DMS front face will not distort in a manner that adversely affects LED message legibility

(3) Front Face Finish.

(a) The front of the housing must be finished semi-gloss black. The sign face and all its parts must be coated with polyvinylidene fluoride resin (PVDF) which has an expected outdoor service life of 15 years

(b) The PVDF resin coating is to be applied by the PVDF manufacturer's certified applier

(c) All other DMS housing surfaces and DMS mounting Z-bars will be natural mill-finish aluminum

(4) Display

The full matrix display units must have the minimum number of pixel rows and columns as listed in Table 3. These minimums are based upon the number of desired characters listed in the table, displayed in a 5 pixel wide by 7 pixel tall character font, with one unlit pixel column between adjacent characters and two (two) unlit pixel rows between lines. These represent the minimum acceptable number of pixels per unit

**Table 3: Pixel Rows and Columns**

| Character Size | Number of Lines | Characters Per Line | Minimum Pixel Rows | Minimum Pixel Columns |
|---|---|---|---|---|
| 9 inch | 2 | 10 | 16 | 59 |
| 9 inch | 2 | 16 | 16 | 95 |
| 9 inch | 2 | 21 | 16 | 125 |
| 9 inch | 3 | 10 | 25 | 59 |
| 9 inch | 3 | 16 | 25 | 95 |
| 9 inch | 3 | 21 | 25 | 125 |
| 12 inch | 2 | 10 | 16 | 59 |
| 12 inch | 2 | 16 | 16 | 95 |
| 12 inch | 2 | 21 | 16 | 125 |

| | | | | |
|---|---|---|---|---|
| 12 inch | 3 | 10 | 25 | 59 |
| 12 inch | 3 | 16 | 25 | 95 |
| 12 inch | 3 | 21 | 25 | 125 |

(a) LED Display Modules

The DMS will contain LED display modules, which will be placed side by side to form the LED pixel matrix. Each display module will be constructed as follows:

(i) LED display module electrical connections will use the quick-disconnect locking connector type. Removal of a display module from the DMS, or a pixel board from its display module, will not require a soldering operation

(ii) It will not be possible to mount a display module upside-down or in an otherwise incorrect position within the DMS display matrix

(iii) All LED display modules, as well as the LED pixel boards will be identical and interchangeable throughout the DMS

(iv) Removal of a single display module from the DMS, or failure of a single module, will not affect the performance of any other module in the sign. Removal of one or more modules will not affect DMS structural integrity or the structural integrity of the rest of the LED display matrix

(b) LED Display Boards

Each display module will contain a printed circuit board to which LED is soldered Each module will contain appropriate number of LED pixels determined by size of module. Each pixel will contain a cluster of closely spaced discrete LEDs. Pixels will conform to the following specifications:

(i) The distance from the center of 1 pixel to the center of each adjacent pixel, both horizontally and vertically, will be 1.33 inches for 9 inch character signs and 1.81 inches for 12 inch character signs

(ii) A pixel will consist of two strings of discrete LEDs

(iii) Current limiting resistors or constant current LED driver subsystem ICs will be used to prevent LED forward current from exceeding 30 mA whenever a forward voltage is applied. LED drive currents greater than 30 mA will not be allowed to maximize LED service life

(iv) Pixels will contain the quantity of discrete LEDs needed to generate a sign display luminous intensity of 9,200 Cd/m2 minimum when the pixel is driven at its proper forward current. However, the minimum number of LEDs for 1 pixel is four

(v) The failure of an LED string will not cause the failure of any other LED string or pixel in the DMS. Failure of a pixel will not cause the failure of any other pixel in the DMS

(vi) Each pixel string will contain an identical quantity of LEDs

(vii) LED pixel forward voltage drop, measured from the DC power supply output to ground, will not exceed 24 VDC. This includes the drive circuit voltage drop and any internal DC line loss

(viii) LED pixel power will not exceed 1.5 watts

(ix) The circular base of the discrete LEDs will be soldered so that they are flush and parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs will be perpendicular to the circuit board

(x) All exposed metal on both sides of the LED pixel board, except the power connector, will be protected from water and humidity exposure by a thorough application of acrylic conformal coating. Bench level repair of individual

pixels, including discrete LED replacement and conformal coating repair, will be possible. The LED driver circuit subsystem is to be able to determine if the pixel is operating normally. This information will be reported to a system control computer upon command from the DMS control software

(xi) All LED pixel boards will be identical and interchangeable throughout the DMS

(c) Discrete LEDs

DMS pixels will be constructed with discrete LEDs manufactured by the Toshiba Corporation or Avago Technologies formally Agilent Technologies. Substitutes will not be accepted. Discrete LEDs will conform to the following specifications:

(i) LEDs will be non-tinted, non-diffused, high-intensity, solid-state lamps that utilize AlInGaP semiconductor technology

(ii) LED lenses will be fabricated from UV light resistant epoxy;

(iii) The LED lens diameter will be 0.2 inches in a T1-3/4 style LED package (surface mounted LEDs will be consider upon submittal);

(iv) LEDs will emit amber light that has a peak wavelength of 590 $\pm$ 5 nm. Color sorting will be performed by the LED manufacturer

(v) LEDs will be obtained from no more than two bins luminous intensity sort. Intensity sorting will be performed by the LED manufacturer

(vi) All 30-degree LEDs will have a nominal viewing cone angle of 30-degrees with a half-power angle of 15-degrees measures from the longitudinal axis of the LED

(vii) LED view tolerance will be +/- 3 degrees

(viii) LED package style will be through-hole flush- mount; LEDs with standoffs. Surface mount LEDs will be considered upon submittal

(ix) All LEDs used in all DMS provided for this contract will be from the same manufacturer and of the same part number

(d) Pixel Drive Circuitry

(i) LED pixels will be directly driven using pulse width modulation. This drive method varies the current pulse width to achieve the proper display intensity level for a given ambient light condition. The drive current pulse will be modulated from a 1.024 millisecond period, and pulse amplitude will not be allowed to exceed 20 mA per LED string

(ii) The pixel modules will be driven by a driver circuit subsystem that will control all applicable pixels on that module or modules

(5) Regulated DC Power Supplies

The LED pixel display matrix will be powered with regulated redundant DC power supplies that operate from 120 VAC/60 Hz input power and have an output of no more than 24 volts DC. Power supplies will:

(a) Protect the LED pixel matrix and driver circuitry in the event of power spikes or surges

(b) Maintain the appropriate LED display intensity in the event of a brownout (low power) condition

(c) Power supplies will be wired in a redundant parallel configuration that uses multiple supplies for the DMS display matrix

(d) Power supplies will be rated such that if one supply fails, the remaining supplies will be able to operate 100% of the pixels in that display section at full brightness when the internal DMS air temperature is less than or equal to +140° F

(e) Regulated DC power supplies will conform to the following specifications:

(i) Maximum output power rating of 1000 watts
(ii) Operating input voltage range: +90 to +250 volts AC
(iii) Operating temperature range: -40 to +140° F
(iv) Power supply output at an ambient temperature of +140° F: 65% of the room temperature (+72° F) output
(v) Power supply efficiency: 74%
(vi) Power factor rating: 0.95
(vii) Short circuit protection: DC power off, with an automatic reset after 5 seconds of AC power off
(viii) Minimum overload allowance protection: 105%
(ix) UL listed

(f) Power supplies will be identical and interchangeable throughout the total number of DMS furnished under this contract
(g) The DMS sign controller will be able to monitor power supply operational status (as “pass” or “failed”) by reading a diagnostic signal located on each supply’s DC output. The operational status of all power supplies will be reported to the DMS control software upon request

(6) Interior DMS Environment Control
(a) The DMS will contain a ventilation system that exhausts air out of the housing whenever the internal DMS air temperature exceeds +90° F. This system will be designed to keep the internal DMS air temperature lower than +140°F, when the outdoor ambient temperature is +115° F or less
(b) Exhaust fans will be the ball-bearing type and will be mounted in a line across the upper rear DMS housing wall. One fan at a minimum will be installed per each exhaust port
(c) One filtered air intake port will be provided for each exhaust fan. Intake ports will be located in a line across the bottom portion of the rear DMS wall. Each intake port will be covered with a filter that removes airborne particles measuring 500 microns in diameter and larger
(d) Fans and air filters will be removable and replaceable from the front or rear of the DMS housing
(e) An aluminum hood attached to the rear wall of the DMS will cover each air intake and exhaust port. Openings will be screened to prevent the entrance of insects and small animals. All intakes and exhaust hoods will be thoroughly sealed to prevent water from entering the DMS
(f) A thermostat used to activate the ventilation system will be located near the top of the DMS interior

(7) Communication Specifications
(a) The DMS sign controller will contain a minimum of one serial port, one dial up port and one 10/100Base-T Ethernet communication port. This port will be available for optional use for communicating from the central control system to the DMS sign controller when an Ethernet network is available. The Ethernet port will be a standard RJ-45 jack
(b) The DMS equipment and software must comply with the most recent version of the following standards, including all recommended or approved amendments, in effect as of the bid date
(i) NTCIP 1101, NTCIP Simple Transportation Management Framework (STMF)
(ii) NTCIP 1103, NTCIP Transportation Management Protocol (TMP)
(iii) NTCIP 1201, NTCIP Global Object (GO) Definitions

(iv) NTCIP 1203, NTCIP Object Definitions for Dynamic Message Signs (DMS)
(v) NTCIP 2101, NTCIP SP-PMPP/RS232
(vi) NTCIP 2201, NTCIP TP-Transportation Transport Profile
(vii) NTCIP 2202, NTCIP Internet (TCP/IP and UDP/IP) Transport Profile
(viii) NTCIP 2301, NTCIP AP-STMF

(8) Software and NTCIP Documentation
(a) Any and all software provided must be supplied with full documentation in hard copy and on CD-ROM. The manufacturer must allow the use of any and all of the documentation described above by any party authorized by MDOT for system integration purposes, system maintenance, or system enhancement at any time, regardless of what parties are involved in the system integration effort
(b) Supply full documentation on a CD-ROM containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format
(c) If the device does not support the full range of any given object within a Standard MIB Module, a manufacturer specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the “syntax” and/or “description” field of the associated object type macro. The filename of this file must be identical to the standard MIB Module, except that it must have the extension “man”

(9) Ambient Light and Temperature Measurement System
(a) Sensors that measure outdoor ambient light levels at the DMS site, as well as the outdoor ambient temperature, will be mounted in-line with the DMS housing walls. This ambient light and temperature measurement system will consist of three photoelectric sensors and one internal temperature sensor, and one external temperature sensor
(b) Two of the photo sensors will be placed such that they measure the ambient light levels striking the front and rear DMS housing walls. The third photo sensor will be mounted to the DMS housing bottom or top. A change in the amount of light striking a photo sensor will cause its output frequency to vary. The DMS sign controller will continuously adjust LED display matrix intensity to a level that creates a legible DMS message

(10) Internal Temperature Measurement System
(a) The DMS will contain a minimum of one temperature sensor that is mounted near the top of the DMS interior. Sensors will measure a minimum temperature range of -29.2°F to +165°F. The internal temperature sensor output will be continuously monitored by the DMS sign controller and will be reported to the DMS control software upon request
(b) An ambient temperature sensor will be mounted to either the rear wall or bottom side of the DMS housing. The sensor will be placed such that it is never in direct contact with sunlight or is in any location that will generate a false temperature measurement. The external temperature sensor output will be continuously monitored by the DMS sign controller and will be reported to the DMS control software upon request

(11) Transient Protection
(a) The DMS surge protection will be a cascade protection system. A primary surge protection device (SPD), connected in parallel with the load, will have a surge capacity of 150kA, providing protection modes between Line to Neutral, Line to Line, Line to Ground. A secondary SPD will be a series connected device,

either "power strip" type if modules are "plug-in" or hard wired if the DMS modules are hard wired. The secondary SPD will have a surge current capacity of no less than 50kA and a current load of minimum 12 amps and neutral to ground

(b) The primary surge protection device will utilize Metal Oxide Varistor's (MOV) technology. The secondary surge protector will be a multi-stage hybrid utilizing various technologies

(c) The surge protection units will have both over current and thermal safety fuses

(d) The surge protection system will reset automatically and be maintenance free

(e) The primary and secondary surge protection device will have status indicators showing "power on", good condition and failed condition

(f) Dry contacts will be incorporated into the "Primary" surge protection device that will provide remote status indication in the event of a failure & fuse activation

(g) All wiring to/from the DMS will have "circuit appropriate" surge protectors installed at both ends, if the circuits are between the sign and controller cabinet

(h) Ambient temperature rating of the surge protection system must be a minimum of -29.2ºF to +165ºF

L. Earth Grounding.

(1) The DMS manufacturer will provide one earth ground lug that is electrically bonded to the DMS housing

(2) The lug will be installed near the power entrance location on the DMS housing's rear wall

(3) The DMS installation contractor will provide the balance of materials and services needed to properly earth ground the DMS

M. Sign Controller Hardware Specifications.

(1) Each DMS will use an associated sign (local) controller. The sign controller and associated communication equipment may be installed using one of the following methods

(a) Inside ground-mounted ITS Cabinet located near the sign

(b) Inside a pole-mounted ITS Cabinet attached to the DMS support structure

(2) The sign controller will have the following characteristics:

(a) Stand-alone microprocessor-based unit with integrated watchdog circuitry

(b) Internal regulated DC power supply

(c) Memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation

(d) Includes front panel user interface with LCD and keypad for direct operation and diagnostics

(e) Mounts in a standard EIA 19-inch (480 mm) equipment rack using the supplied mounting hardware

(f) Maximum weight of 10 pounds, including its enclosure

(g) Built-in rechargeable battery backup circuit that can provide the controller with power briefly when the primary AC power source fails

(h) Minimum one NTCIP-compliant RS232 communication port for serial communications. One of the serial ports will have a secondary RS422 interface option

(i) One Ethernet port with RJ45 connector supporting NTCIP communication

(j) Built-in Hayes-compatible modem with standard RJ11 connector

(k) Operate successfully throughout a temperature range of -29.6°F to 165°F

(l) Communicate directly with the distribution board located in the DMS, which communicates with all sensors, LED driver circuit subsystem, and other devices
(m) Include DMS-specific control firmware (embedded software) that will handle all external and internal sensors and communication inputs and drive the display modules as directed by external control software

(3) The sign controller will have non-volatile changeable memory. This memory will be formed by a combination of Flash ROM and battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power failure. This changeable memory will be used to store messages and schedules. The minimum number of changeable messages that can be stored within the sign controller will be 500

N. Front Panel User Interface.

(1) The sign controller's front panel will include a keypad and LCD. These devices will be used to perform the following functions with the sign controller and DMS:
(a) Monitor the current status of the sign controller, including the status of all sensors and a representation of the message visible on the display face
(b) Perform diagnostics testing of various system components, including pixels, power systems, sensors, and more
(c) Activate messages stored in memory
(d) Configure display parameters, including display size, colors, and communications

(2) The front panel interface will also include:
(a) Power switch to turn the controller on and off and an LED "on" indicator
(b) A "local/remote" switch with an LED indicator that places the controller in local mode such that it can be controlled from the front panel interface, instead of via the primary communication channel
(c) Reset switch to quickly restart the controller
(d) LED "Active" indicator blinks when the controller is operating
(e) LED to indicate when any of the NTCIP communication channels are active; and
(f) A serial communication port ("Local") will allow connecting a laptop directly to the controller

O. Battery Backup.

The DMS sign controller located within the ITS Cabinet will be connected to the rechargeable battery backup circuit (UPS) that will allow the controller to operate for a minimum of 30 minutes if the incoming AC power source fails. The battery backup circuit (UPS) will supply enough power to backup all internal systems of the DMS sign controller, including RS232, Ethernet and dialup modem communications.

P. Display Interface.

(1) The DMS sign controller will transmit and receive data packets to and from a distribution board. The distribution board will communicate with all sensors, drivers, and other devices using multiple networks running throughout the DMS

(2) Data transferred will include pixel states, sensor values, and I/O readings from various devices, such as door sensors and power supply monitors. Pixel data will include the states to be displayed on the sign face as well as diagnostic data retrieved from the LED driver circuit subsystem

(3) Communication from the sign controller to the distribution board will be using fiber optic cables or copper communications cable that connect the DMS sign controller to the DMS driver board subsystem

Q. Sign Controller Addressing.

(1) The DMS sign controller will use multiple types of addressing when operating on NTCIP communication networks. The addressing will be configurable through the front panel user interface
(2) When operating over PMPP serial networks (NTCIP 2101), the controller's address will be configured in the range 1 to 255. The default address will be 1
(3) When operating on Ethernet networks (NTCIP 2104) a static IP address and subnet will be used
(4) If a dial-up or direct connect serial network is configured for PPP (NTCIP 2103), then no addressing will be required

R. DMS Intensity Control
(1) Variable message signs will include an LED intensity control system that uses pulse width modulation (PWM). Over 100 intensity levels will be available. The DMS sign controller will be able to automatically adjust the LED display matrix intensity. A system operator will be able to override the automatic system, in order to manually change the LED intensity
(2) The DMS intensity control will:
(a) Utilize three photoelectric sensors, which are provided and installed as described in the DMS specification. It will use these measurements to automatically determine which LED intensity level will provide the best legibility for the given ambient light condition
(b) Select from a minimum of 100 LED intensity levels. LED intensity levels will be available in a range of 1% to 100% of the maximum display intensity, and in increments of 1%
(c) Not cause any flickering of the LED display matrix
(d) Allow manual and automatic intensity control modes to be user selectable using the DMS control software, although the typical control mode will be "automatic"
(e) Allow manual intensity control from both local and remote locations

S. LED Diagnostic Test Capability.
(1) Upon command from either a remote computer or local laptop running the central control software, the sign controller will test the operation of all LED pixels and determine whether their functional status is: "Normal" or "Stuck-Off". Pixel status will be determined via A/D conversion of the LED pixel forward voltage, and the resulting data will be communicated to the DMS control software
(2) The resulting data will be transferred to the may be monitored via the front panel and NTCIP interfaces

T. Real-Time DMS Message Verification.
(1) The DMS sign controller and LED module hardware will be capable of enabling the DMS Central Control operator to verify the actual message displayed on the DMS on a real-time basis
(2) This message verification will be presented in a WYSIWYG format without disrupting the message displayed on the DMS
(3) WYSIWYG will be performed automatically each time the DMS is polled for status by the central control software

U. Power Supply Diagnostic Test Capability.
(1) The sign controller will be able to determine the functional status of regulated DC power supplies located in the DMS by monitoring diagnostic outputs located on the supplies
(2) This information will be reportable as "Pass" or "Failed" to the DMS control software.

V. Response to Errors.

(1) In the event of communication error between the DMS sign controller and the system control computer; the “communications loss message” will be displayed. This will be factory disabled
(2) In the event of a power failure, the “power recovery message” will be displayed. This will be factory set to blank the DMS
(3) The DMS sign controller will contain a hardware watchdog that automatically resets the controller’s microprocessor in the event of a controller lock-up

W. Over Temperature Shutdown.
(1) The DMS will utilize an internal temperature sensor circuit that will be monitored by the sign controller
(2) The DMS will be capable of being configured to automatically blank the sign face if the internal temperature of the DMS exceeds a configurable threshold
(3) If this occurs, the sign controller will also notify the central control system

**c. Construction.**

A. Warranty.

The DMS must carry a manufacturer’s standard warranty (parts, labor, any required MOT) of five years from the date of installation of the individual DMS. Supply a factory trained Technician to observe and oversee the DMS installation process for each sign. The Technician is to verify that the installation practices follow the DMS Vendor’s Standard Operating Procedure (SOP) and during the installation did not in any way void or limit the Vendor’s warranty. Once released by the Department and with the Vendor Technician’s approval, the Warranty will begin.

**d. Measurement and Payment.** The completed work will be paid for at the contract unit prices for the following contract items:

| **Contract Item (Pay Item)** | **Pay Unit** |
|---|---|
| Dynamic Message Sign, Small ..... | Each |
| Dynamic Message Sign, Small, Fnd and Structure..... | Each |

**Dynamic Message Sign, Small** will be measured as each sign furnished, installed, and integrated into the ITS Network. The DMS sign physical size and general matrix configuration will be as depicted within the Project Plan Set.

**Dynamic Message Sign, Small, Fnd and Structure**, will be measured as each sign foundation and structure furnished and installed. This line item includes but not limited to the design of the sign foundation based on the Contractor’s geotechnical investigation, the design of the sign structure, the furnishing and installation of all required mounting brackets, the sign foundation and the sign structure.